ALLTED, ALL-TECHNOLOGIES SYSTEM DESIGNER

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Abstracts

ALLTED is a personal computer oriented CAD system for nonlinear dynamic systems design. It is based mostly on original algorithms and possesses some important adaptation features to ill-conditional tasks and DC, TR stiffness. It provides a powerful procedure of automatic determination of secondary response parameters (delays, rise and fall times, frequency band, resonance frequency, etc.) and calculation of functions of these parameters. In following design these secondary parameters and their functions become variables which are optimized (with parametrical and functional constraints for one-or-multicriterional tasks) or for which sensitivities, WC, permissible tolerances and statistical characteristics (including histograms) are calculated.

1. Introducing ALLTED

ALLTED covers all the design steps from the initial schematic diagram drawing to the ready-to-geometrically-design version. To determine all the parameter values to meet the end specification requirements the mathematical model of an object is automatically constructed and steady-state, transient, frequency, statistical (Monte Carlo), Spectral (Fourier) analyses are carried out. This is followed by high-level operations such as Worst Case, sensitivity analysis, optimization, optimal tolerance assignment, etc.

Beside electronics ALLTED has very important nonelectrical applications (aircraft, robotics, machine-tools, etc.) and provides a customer-defined models for electronic, hydraulic, mechanical, pleumatic, and/or electromagnetic components.

At first glance it is clear that ALLTED has SPICE-like appearance and functionality with the usual list of circuit simulation features:

- Schematic capture (fig. 1) and Graphics Editor (fig. 2);
- Output graphics (fig. 3 and fig. 4), postprocessor;
- Device parameters identification Subsystem;
- Use-defined Models and Functions;
- Mixed-mode (analog/digital) simulation;
- Basic Analysis (DC, TR, AC, Four);
- Component models libraries;
- On-line helps, prompt/diagnostic message system;
- Advanced Analysis (Monte Carlo, SA, WC) for DC, TR and AC although SPICE provides SA and WC only for DC.

We now leave the SPICE family further behind with a brief survey of ALLTED advanced features.

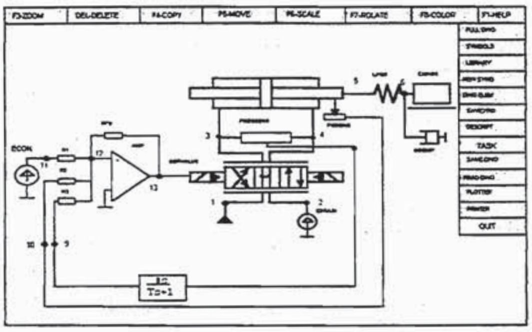

fig.1. Schematic diagram.

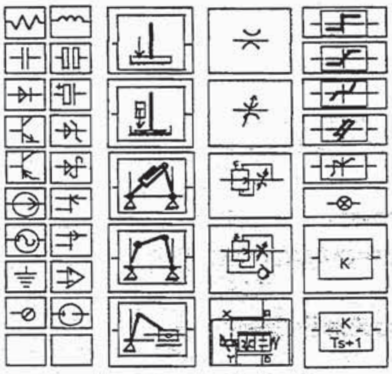

fig.2. ALLTED Graphics Editor icons

2. Advanced features

It is important to understand that the automatic analysis capability of ALLTED is not restricted to just computing such primary response quantities as voltages, currents, and power, but also provides job control options.

With the job control options the user can command the calculation of a wide variety of defined secondary response quantities such as rise times, peak values and bandwidths, along with t-values or w-values at which such points occur, as well as arbitrary mathematical functions of such quantities. Also the Monte Carlo and sensitivity analyses are not restricted to primary responses but can equally well reference any user defined secondary response [1,2].

Another set of features which puts ALLTED in a class by itself is that it brings to designers very general and very powerful circuit optimization capabilities [3,6]. These are unconstrained optimization and constrained optimization in which the variable elements values must fall within prescribed upper and/or lower bounds. Constrained optimization in which some elements values are required to be prescribed functions of the variable elements values.

The optimization objective can be simple, like finding an extreme of some value of some primary or secondary response quantity. Or used to determine element values which bring such a quantity close to a prescribed value. Or used to find element values which put such a quantity into a prescribed range. The objective can be a multiple, described by a vector of scalar objective functions.

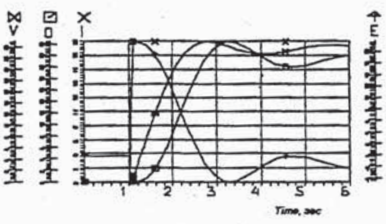

fig. 3. Transient response

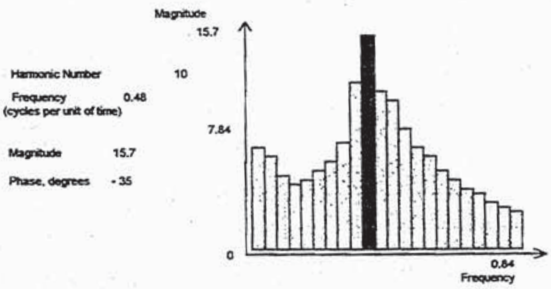

fig. 4. Spectrogram example.

Since no single interpretation can fit all cases, variety of treatment alternatives is provided for multiple objective problems, ranging from optimizing a simple weighted sum to more suitable Pareto optimizing conditions.

And finally, the software is not limited to a single technology [3]. It may be used with other technologies singularly or in combination, with existing libraries of with user-defined functions. ALLTED is a design tool without limits. ALLTED is used now for teaching at Kiev Polytechnic Institute and Michigan State University, USA, where the author was a Visiting Professor at 1991.

Because of original mathematical algorithms [4,5,7] being used ALLTED requires very simple hardware for ranning: any IBM compatible computer with 640 RAM and MS DOS 3.20 or later. It needs from 4 to 20MB space on a hard disk, graphic monitor (black/white or color), and color graphic adapter CGA, EGA, or VGA. Co-processor, Microsoft mouse or compatible, and full extended memory capabilities are the optional enhancements.

3. Example

The optimization capability of ALLTED is illustrustared by fig. 5, where there are task file (fig. 5,a) and optimization results (fig. 5,b).

The problem in hand is Carry Chain circuit, consisted of four Carry Cells subcircuits each of which contains six transistors described by BSIM models, having 40 different parameters.

Selected ten optimal parameters (channel widths of 10 transistors) are satisfied the condition of minimal delay Tdel for fall edge of output pulse Vxor.

The optimization procedure was subjected to following constraints and conditions:

a) Wp/Wn <=5 for all transistors (see function f 258 at line 16 of the Task fine at fig. 5,a);

b) Wp/Wn >=2 for all transistors (function f 259);

c) all Wn values of n-channel transistors was variated synchronously (line 14 of the Task file);

d) all Wp values of p-channel transistors was variated synchronously (line 15 of the Task file);

e) the following objective function

F5=min (Tdel) was used (line 12 of the Task line), where Tdel is delay for fall edge of output pulse VXOR;

f) Tdel was defined by statements FIX and INTERVAL (lines 10 and 11 of the Task file).

task

```
1 dc;
2 tr;
3 optim;
4 const DCMAXIT=50;
5 const TMAX=25.n;
6 const MINSTEP=1, e-15;
7 const DIPLOT=0.5n;
8 plot VinA, VXOR;
9 #;
10 fix Tin=fall (VinA,2.5), Tout=fall (VXOR,25);
11 int Tdel=Tout-Tin;
12 of Ordel=f591/tdel);
13 const METHOD=140,NUMB=10, MAXOF=1.28n;
14 varpar W.m11=W.m12=W.m21=W.m22=W.m23(3.u,9.u),

15          W.m13=W.m14=W.m24=W.m25=W.m26(10.u,18.u);
16 limit ups=f258(5/W.m13,W.m11), low=f259(2/W.m13,W.m11);
17&
134/1 Task syntax correct
```

a)

```
**************************************************************************************
                         OPTIMIZATION RESULTS
      SOLUTION IS FOUND
      OTDEL             =0.1276815986D-08
      OPTIMAL VALUES OF VAR COMPONENTS
      W.M11             =0.4707571860D-05
      W.M12             =0.4707571860D-05

      W.M21             =0.4707571860D-05
      W.M22             =0.4707571860D-05
      W.M23             =0.4707571860D-05
      W.M13             =0.1800000060D-04
      W.M14             =0.1800000060D-04
      W.M24             =0.1800000060D-04
      W.M25             =0.1800000060D-04
      W.M26             =0.1800000060D-04

      VALUES OF CONSTRAINTS IN OPTIMAL POINT
      UP                =-0.1176372625D+01
      LOW               =-0.1823627375D+01
```

b)

Fig.5. Task file (a) and optimization results (b)

Showing a particular number of optimization method to be used (line 13 of the Task file) the end-used can select between:

- shrinking random method;
- Quasi-Newton methods (Fletcher's, Brayden's, DFP);
- generalized variable order method, which uses four terms of Taylor's expansion for an objective functions;

- conjugate directions method;
- modified Agnew's minimax method;
- combined random/demerminishic method;
- parameter group relaxation procedure.

In the case of hand a combined random/generalized variable order method was used.

4. Conclusion

The primary goal of any software system is optimal design. All other operations such as mathematical model developing and ordering, solution of equations, evaluation and identification of output characteristics during numerous analysis, while very important, simply lay the foundation for optimization.

Significantly ALLTED solves the optimization problems directly and effectively using a platform of ordinary PC. For further information:

http://www.cad.polytech.kiev.ua

We would like to find partners for callobaration in the following directions:

- updating unique mathematical algorithms developed at Ukraine which are an order of magnitude faster and reliable that competitors' ones to Modern Computer Framework based on workstations with OS UNIX or MS Windows NT and X-Window based graphical interface;
- using design software standards for data representations, data management, user interfaces, etc.;
- providing possibility of fault and defect analysis, maintenance aging modeling, optimal tolerances assignment;
- organizing α and β testing updated ALLTED at Western Universities and Industrial Companies;
- developing Network version of software for collective use.

5. References

[1]-Petrenko A., (1982), "Fundamentals of Computer-aided Design", Kiev:Technika Press.

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[5]-Petrenko A., Omer-Imerely A., (1990), "Curve-Search Algorithm for DC Analysis of Non-Linear Electronic Circuit", International Journal of Circuit Theory and Application, Vol (18), pp401-409.

[6]- Petrenko A., Sigorsky V., (1975), "Algorithmic Analysis of Electronic Circuits", San Francisco, Western Periodical Co.

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